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Publication Committee

C. H. CLARK, *Chairman* — PROF. E. R. SCHWARZ

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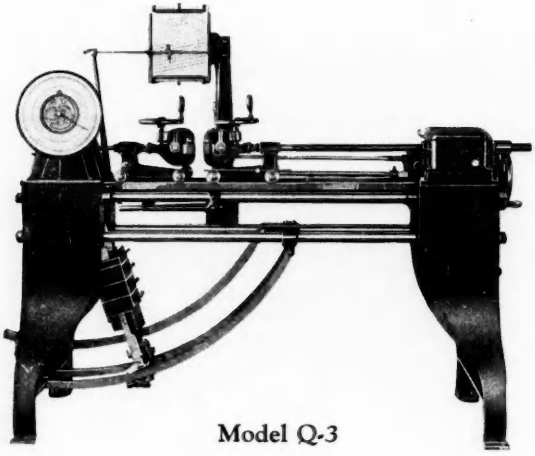

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TESTERS

The Editor's Page

Summer Session on Textile Analysis at M. I. T.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY announces that a Special Program in Principles of Textile Analysis will be offered during the coming Summer Session, beginning July 24th and continuing through six weeks to September 1st. A comprehensive program for the study of textile technology and research will be conducted and will include lectures and demonstrations together with laboratory work for the six-week period each day with the exception of Saturdays. So far as possible the material will be presented in a manner to be of interest and value to the teacher of this and allied subjects, to the laboratory technician, to the manufacturer who must interpret technical information developed by textile research for the benefit of his organization, and to the student who seeks a short orientation course in textile technical analysis.

Degree of Master of Science in Textile Technology

During the past year the Textile Laboratories of the Institute have been completely rebuilt and additional equipment for physical, optical and physical-chemical analysis of textile materials has been provided. Increased and improved dark room facilities are available; a much improved microscopical laboratory, two physical testing laboratories and an additional fundamental research laboratory have been provided as separate units. Further, the Department of Mechanical Engineering has set up a division of Textile Technology in charge of Prof. E. R. Schwarz which will serve to correlate work on fibre research and allied subjects throughout the Institute. The Corporation of the Institute has also authorized the granting of a degree of Master of Science in Textile Technology beginning with the academic year 1939–40.

* * *

Conference of Textile Foundation's Research Staff

SCIENTIFIC RESEARCH WORKERS on the staff of the Textile Foundation and members of the Foundation's Advisory Committee for Scientific Research met in a conference recently at the National Bureau of Standards, Washington, D. C., which is reported to have resulted in a better understanding and closer co-ordination of the Foundation's research activities, and that administratively the work will move along with increased effectiveness. Joining the group of twelve from the Washington laboratories were representatives of projects under way at the University of North Carolina, Massachusetts Institute of Technology, Yale University and the Lowell Textile Institute. Franklin W. Hobbs, chairman of the Board of Directors, attended the conference, which was presided over by Dr. Robert E. Rose, chairman of the Advisory Committee for Scientific Research. Other mem-

bers of the committee present were Alban Eavenson, Warren E. Emley, Harold DeW. Smith, E. R. Schwarz, Hugh S. Taylor and R. Y. Winters.

25th Anniversary of Committee D-13

COMMITTEE D–13 (Textiles) of the American Society for Textile Materials celebrated its 25th anniversary at a banquet held in conjunction with its meeting in Providence, R. I., March 1–3. A paper by Horace J. Jaquith, of Minot, Hooper & Co., who was one of the original members, traced "The History of Committee D–13 From its Organization in 1914," and Prof. H. J. Ball, chairman of the Committee, presented a paper on "Committee D–13 and the Textile Industry."

Sub-committee A–2, Section I, under the chairmanship of Ashton M. Tenney, discussed revisions in "tentative methods of testing and tolerances for continuous filament rayon yarn" and agreed upon material reductions in previously proposed tolerances. It was also agreed that specifications under this title shall be confined to cellulose or modified cellulose materials.

Sub-committee A–2, Section II, under the chairmanship of Alexis Sommaripa, discussed a progress report on fabric shrinkage, and the proposed methods of testing unraveling of seams in washing.

Sub-committee A–2 Section III, under the chairmanship of Kenneth B. Cook, discussed proposed methods of testing and tolerances for rayon staple, with special emphasis upon test methods for denier, length and tensile strength.

* * *

Alpha Protein and Fibre from Soy Beans

THAT ALPHA PROTEIN is being produced in commercial quantities from soy beans by The Glidden Company, paint and varnish manufacturers, Cleveland, Ohio, and that satisfactory fibre has already been produced therefrom is stated by W. J. O'Brien, vice-president of that company. In answer to an inquiry of *Textile Research* Mr. O'Brien writes as follows:

"We are now operating a rather large unit in Chicago producing a considerable tonnage of alpha protein. We have had fibres made from this soy bean protein both in Italy and in this country and have had considerable encouragement. We are conducting at the present time further research on the production of fibre, studying particularly certain fundamentals involved. You can accept as authoritative that The Glidden Company is now producing economically soy bean protein, and that this soy bean protein has been tested both in this country and abroad and gives a satisfactory fibre."

The raising of soy beans as a comparatively new farm crop in this country was one of the initial objectives of the Farm Chemurgic Council, of which the late Francis P. Garvan, then president of the Chemical Foundation and of U. S. Institute for Textile Research, was the founder. In the Proceedings of the Second Dearborn Conference of the Council (May 1936) are a number of papers delivered at the soy bean sectional meeting, several of which are descriptive of its properties and industrial uses. It is noted that the protein content of soy beans (average, 35 to 40%) is considerably greater than that of any other product of the vegetable kingdom; that it is a relatively simple protein as compared with that of milk casein, which on

hydrolysis breaks down to phosphorus compounds and amino acids, whereas soy bean protein on hydrolysis produces only amino acids. However, the commercial extraction of soy bean protein and its isolation and separation are highly complex problems involving fundamental research. Among those engaged in this research in addition to The Glidden Company are L. F. Laucks, Inc., Seattle, Wash., and the Ford Motor Company's research laboratory.

* * *

Symposium on Cellulose Chemistry

AMERICAN CELLULOSE CHEMISTRY in 1939 is the title of the symposium to be conducted by the Division of Cellulose Chemistry of the American Chemical Society, meeting in Baltimore, Md., April 3 to 7. Among the papers that may be of most interest to textile research workers are the following: "Intermicellar Hole and Tube System in Fibre Structure," H. Mark; "Work on Cellulose at the National Bureau of Standards," Warren E. Emley; "Program of Cotton Quality and Standardization Research in the Division of Cotton Marketing, Bureau of Agricultural Economics, U. S. D. A.," Carl M. Conrad; "Further Investigations on the Growth and Structure of the Cotton Fibre," Thomas Kerr; "Mode of Formation of the Image of the Spierer Lens," Frederick F. Morehead; "Cellulose Derivatives from Whole Cotton," George C. Holroyd and Frank K. Cameron; "Degree of Aggregation of Dyestuffs in Vat Dyeing of Cellulose," Emmerich Valkó (Mannheim, Germany).

* * *

Science and Empiricism

Herodotus described cotton as a kind of wool that grows on wild trees in India. Perhaps he was responsible for the wildly ambiguous term "cotton wool," which because of common usage is accepted by some lexicographers.

* * *

"Independent Laboratory Services" is the title of an attractive brochure issued by the American Council of Commercial Laboratories, of which D. E. Douty, president, U. S. Testing Company, Inc., and a director of U. S. Institute for Textile Research, is secretary. "The member laboratories of this Council," the brochure states, "are carefully selected from among the responsible commercial laboratories of the country. They have bound themselves mutually to maintain the laboratory art upon a high plane and to conduct their operations in such a manner as to insure competency and reliability in whatever they undertake." There are 19 charter members of this group of commercial, analytical, testing and research laboratories.

* * *

Casein fibre fabrics may have to be protected against damage by bacteria as well as by moths if the Dutch scientists quoted in *Science News Letter* are correct. Jan Smit, lecturer in microbiology at the University of Amsterdam, and his colleague B. van der Heide, of Wageningen, have re-

ported on their experiments proving these findings. "It was found," they state, "that nearly all casein-splitting micro-organisms, isolated from soil or manure, or gathered by infection from ordinary atmosphere, are able to attack the (synthetic) wool. The action of the organisms appears to be by means of an enzyme, *i.e.*, by liberating a chemical that attacks the synthetic wool. Heating the fibres and bacteria to the temperature of boiling water appears to destroy the enzyme reaction so that one might speculate whether wearers of such synthetic wool clothing would have to boil their suits periodically."

* * *

Why nylon originally was called "Fibre 66" is shown by Dr. Tenney L. Davis, professor of organic chemistry at M. I. T., to have been logically based on its atomic structure. In an alluminating article on the properties and structure of nylon in the *Technology Review* for March he writes that it was known as nylon 66 "because it is formed from the six-carbon diacid and the six-carbon atom diamine repeated alternately. Six carbon atoms when arranged in a ring constitute a structure which is stable and free from strain. Six is definitely the preferred and natural number of carbon atoms for a stable ring. Further, it has been shown that when six carbon atoms are linked together in an open chain, the system tends to curl up and approach the form of a ring, the ends of the six-membered chain coming fairly near to each other in space. A ring of 12 carbon atoms curls up, as Ruczicka and others have shown, to form a sort of figure 8, each lobe or loop of which contains six carbon atoms. The long chains of the superpolymeric amides are not straight chains but are spirals or corkscrews—and this characteristic of the molecules also helps to account for the strength and elasticity of the fibres which are made from them."

* * *

Personal

Dr. H. DeW. Smith, treasurer and technical director of the A. M. Tenney Associates, was the guest speaker at the March meeting in Montreal of the Textile Society of Canada (Eastern Division). His subject was "Trends in Synthetic Fibre Development." Another guest speaker was Dr. Harold Hibbert, a leading authority on cellulose chemistry, of McGill University.

* * *

Dr. Wanda K. Farr, director of the cellulose laboratory of the Chemical Foundation at the Boyce Thompson Institute, delivered a paper on "Viscose Rayons" at the recent meeting at the Chemists' Club, New York City, of the American Section of the Society of Chemical Industry.

* * *

A. R. Olpin, who has been associated with the research laboratory of Kendall Mills at Paw Creek, N. C., has been appointed director of the Ohio State University Research Foundation, Columbus, Ohio.

* * *

Neil Dow is now head of the research and technical department of Bigelow-Sanford Carpet Co., Inc., succeeding Giles E. Hopkins, recently resigned. Mr. Dow was formerly assistant to Mr. Hopkins.

(*Continued on page 215.*)

Properties of Gelatins and Glues and Their Relation to Warp Sizing

By WILLIAM E. YELLAND *

A Research of U. S. Institute for Textile Research, Inc.

Summary

Previous articles in this series have dealt with some of the properties of starches, both raw and modified. This article is intended to cover briefly properties of glues and gelatins, especially as related to the problem of rayon warp sizing. The confusion in the terminology relating to glues and gelatins is discussed. The difficulties, economic and otherwise, which may possibly occur when buying size in liquid or semi-liquid form are pointed out.

Introduction

THE terms "glue" and "gelatin" are used rather loosely and do not always have the same significance. Broadly speaking, when stock consisting of the hides, or bones, or connective tissues of animals is extracted with water under carefully controlled conditions complex mixtures of proteins are obtained. These mixtures are known as "glues" and "gelatins." Thus a glue or a gelatin is not a pure compound in the chemical sense; it is a conglomeration of several hundred similar compounds so blended that the resultant mixture answers to certain physical tests such as viscosity and gel strength. The success of a gelatin or glue manufacturer depends largely on how skillfully he can blend the concentrates from a number of extractions to produce a mixture whose properties will not vary appreciably from what is desired. Many firms have developed this blending technique to a high degree so that their products are as uniform and standard as such complex mixtures can be expected to be.

The term "glues" also includes vegetable glues made from starches, water-resistant glues obtained from albumen and casein, and liquid glues produced from fish. None of these are included in this article.

In the manufacture of glues and gelatins the stock is extracted with water at comparatively low temperatures at first. Subsequent extractions are made at progressively higher temperatures until 212° F. is reached. The products obtained in the first runs are usually of lighter color and possess higher gel strength and viscosity than those obtained from later runs. Many people prefer to think of the products obtained in these first

* Dr. Yelland was director at Massachusetts Institute of Technology of the filament viscose rayon phase of the warp sizing research from Jan. 1, 1936 to Sept. 30, 1938.

runs as "gelatins," and consider those obtained from later runs made at higher temperatures as "glues." Thus, in the minds of these people at least, the properties of high gel strength, high viscosity and lighter color are associated with "gelatins," while the properties of low gel strength, low viscosity and darker color are attributed to "glues."

"Edible gelatins" are made specially selected high grade stock under sanitary conditions which conform to food law specifications so that they contain a minimal bacteria count. They also conform to certain requirements concerning the absence of harmul salts, such as those of lead, arsenic, copper, etc.

A different nomenclature is used by other people. These consider the products obtained in all the runs as "glues." When these products have been refined by clarification and bleaching they are termed "gelatins." Thus, according to this system, a "gelatin" is a refined "glue" and may or may not possess a higher gel strength and viscosity than a glue.

For the purpose of simplifying matters the first system will be used in this article, but it must be borne in mind constantly that there is this confusion of terms in the trade.

It should be noted here that the term "First Run Gelatin," implying high grade, has no significance unless qualified by a statement as to the per cent gelatin extracted from the hides during the run. It is possible to increase the amount extracted by raising the temperature and increasing the time of cooking. Thus, as large an amount of material may be obtained in one run as would be obtained in several runs at lower temperatures and shorter times of cooking. Needless to say the first method gives material which is inferior in quality, but larger in amount, in the first run than does the second method. Yet each product may be termed a "First Run Gelatin."

Test Methods

Since a glue or a gelatin, no matter how "pure" it may be labelled, is an extremely complicated mixture of hundreds of compounds, there is no single test by which it may be evaluated for the purpose of warp sizing. An ultimate chemical analysis—that is, an analysis in which the per cent nitrogen is determined—is of little importance because glues and gelatins having widely different properties often contain the same per cent nitrogen. Such an analysis would show whether or not compounds other than proteins —e.g., dextrines—had been added to the glue or gelatin. But these compounds are usually determined more readily by other methods. So an ultimate analysis is not of value from the point of view of the mill man.

Tests which can be used in grading a glue or gelatin are as follows: (1) viscosity, (2) gel strength, (3) moisture content, (4) ash, (5) acidity or pH, (6) water absorption. No one of these alone is sufficient to characterize a glue or gelatin.

Samples of glues and gelatins have been examined in this laboratory with regard to the above properties. These samples included not only materials recommended by gelatin or glue manufacturers for warp sizing, but also a series of representative products from a number of firms. In addition to these several prepared sizes have been analyzed. This article is based in part on the results of these studies.

Viscosity and Gel Strength.—These two properties are dealt with together as there is an intimate relationship between them, high viscosity being

usually associated with high gel strength. There are, of course, exceptions to this statement, but it is a general rule. The early system of grading gelatins, devised by Peter Cooper, was based on the gel strength. This system was crude, as the strength of the unknown sample was compared with the strength of a standard jelly by pressing it with a finger, "the fourth finger of the left hand being considered the most sensitive." The method now employed is the Bloom test, and the gel strength is termed the Bloom number, or simply the Bloom of a gelatin. This method is described in full detail in the *Journal of Industrial and Engineering Chemistry*, Analytical Edition, Vol. 2, No. 3, pp. 348–51 (1930).

The Bloom number is the weight in grams required to force the plunger of a Bloom gelometer to a depth of 4 mms. into a jelly which has been prepared according to rigid specifications. The Bloom number depends not only on the nature of the sample tested, but also on: (1) concentration, (2) history of the jelly; that is, how the gelatin was put in solution, how quickly it was cooled, how long and at what temperature the jelly was kept before the test was made, (3) the ratio of the area of the plunger surface to the area of the jelly surface, (4) the depth of the sample, (5) the rate and temperature at which the test is made. Conditions (2) to (5) inclusive are met by adhering to the rigid specifications outlined in the article mentioned above. However, there are two concentrations at which the tests are made. Gelatins are tested at a concentration of 6.66%, while glues are tested at a concentration of 12.5%. The Bloom number of a sample on the glue scale is approximately three times the bloom number of the same sample on the gelatin scale. Thus, the term "250 Bloom" means nothing unless you specify which scale is being used. So in comparing gelatins or glues from different producers, one must be sure that the same scale is used. In this report, Table 2, the Bloom numbers and viscosities are given on the glue scale; in Table 3 they are given on the gelatin scale. Sample No. 3, Table 2, is very close to Sample No. 10, Table 3, in physical properties, although at first sight they might seem to differ widely, since the Bloom and viscosities are reported on two different scales.

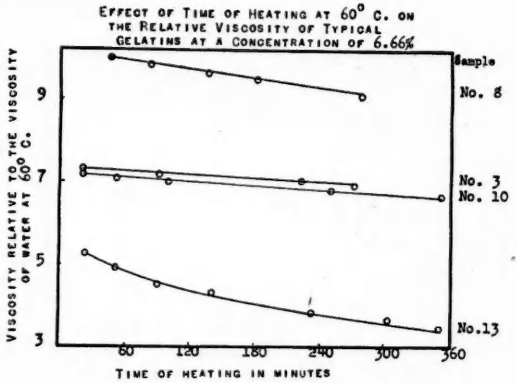
There are other instruments devised for measuring the gel strength which give comparable results when used by technicians skilled in handling gelatin and glue. However, the possible sources of error are so numerous that it is suggested that the measurement of gel strengths be done only in laboratories where all the conditions can be rigidly controlled. For this reason the gel strengths of the samples mentioned in this report were obtained directly from the manufacturers and not determined in this laboratory.

The viscosity of gelatin and glue solutions can be expressed in terms of millepoise (abbreviated, mlp.) or in terms of relative viscosity. In either case the viscosity is measured by allowing the solution to flow through a pipette which has been previously calibrated. The time of flow is multiplied by the calibration factor. During the determination of the viscosity the temperature must be kept constant, as the viscosity is greatly affected by changes in temperature. Most of the gelatin and glue companies express the viscosity in millepoise. (The viscosity of water at 20° C is 10 mlp.) Here again it is necessary to make sure whether or not the scale used is the gelatin scale (6.66% concentration) or the glue scale (12.5% concentration).

In order to have the results comparable with the earlier work on starches, the viscosity of gelatin solutions has been measured relative to the

viscosity of water, and at a temperature of 60° C. ± 0.1° C. This temperature was chosen as it is the temperature frequently used in the size box, that is, 140° F.

The viscosity of a gelatin solution decreases slowly with time over a period of several hours. The actual rate depends on a number of factors such as the pH, and ash content. The viscosity-time curves are given for a number of typical samples in the accompanying diagram.



There is a wide range of opinions existing as to the proper gel strength and viscosity of the gelatin or glue to be used for sizing continuous filament bright viscose rayon. In subsequent articles data will be presented to show the influence of these two properties on the amount of size picked up by the warp and on the distribution of the size on the yarn itself.

Moisture Content.—Like many organic materials, glues and gelatins contain water of constitution. This actually forms an integral part of the molecular structure and is only given up when the compound is destroyed, as by strong heating, or vigorous dehydrating agents such as concentrated sulphuric acid. In addition to this chemically combined water, glues and gelatins have more or less moisture which has been picked up from the air. This moisture is not a part of the molecular structure of the compounds and may be lost or gained, depending on circumstances, without affecting the chemical identity of the material. It is usually known as the "moisture content" and varies with the type of glue or gelatin and also with the conditions under which the material is stored. If it is kept in containers which are not air-tight the moisture content will vary with the relative humidity of the air.

The moisture content can be determined in a number of ways, depending on how accurately one wishes to know it. A simple method which yields results which are accurate enough for most purposes is to dry the sample to constant weight. The details of the technique used in the experiments reported here are given in Appendix I.

This method gave results which were accurate to within 0.5%. Of 26 gelatins which were investigated the minimum moisture content was 8.9%,

the maximum was 14.0% and the average was 10.8% This is in accordance with Teesdale who states: "Ordinary glue (or gelatin) of good quality contains from 8 to 16% water. Too much water indicates poor keeping quality and of course means that the buyer is paying for that much water. Too little water may indicate an overdried glue (or gelatin) which may be injurious to its strength properties."

At this time it may be well to consider prepared sizes which are sold in liquid or semi-liquid form. The water content of such a size is more difficult to determine than that of a glue or gelatin. In many cases it is not possible to determine it to within 2 or 3%. No hard and fast line of procedure can be laid down which will be satisfactory in every case. Sometimes an estimate of the water content may be made by heating the sample to constant weight, as described in the Appendix, being careful that a film does not form on the surface which prevents further evaporation. In other cases this method would cause the loss of constituents which are put in to act as softeners and penetrants, and thus would lead to false conclusions. Each case is unique and should be handled by a competent chemist.

Several of these prepared sizes have been examined in this laboratory. The water contents of four typical samples are given below:

TABLE 1

Sample	Water Content
A	74%
B	66%
C	38%
D	62%

Thus when a mill buys 100 pounds of Size A it is getting—and usually paying for—74 pounds of water and only 26 pounds of active sizing material, such as gelatin, softener, penetrant, and preservative combined. It is claimed that these liquid or semi-liquid sizes are more readily made up into size baths than sizes obtained in the solid form. However, mills are using glues and gelatins daily which can be put into solution by soaking in cold water from 10 to 20 minutes and then heating to 160° F.

The question of buying sizes in liquid or semi-liquid form is partly an economic one to be decided by each mill for itself. If the mill prefers the liquid form, it should make sure that the price is based on the per cent of active sizing material present and not on the total weight. Since the determination of the water present is most readily and accurately made by a person familiar with the actual composition of the size, the size manufacturer himself is the man who can best supply this information. In this connection it is interesting to note that most size manufacturers are willing to put their products on the market in solid form which contains about the same per cent moisture as a good glue or gelatin.

Apart from the economic factor involved in this type of size there is another serious factor; that is, the keeping quality of the size. This is discussed later in this report under the pH of glues and gelatins.

Ash Content.—Ash is determined by ignition of a small sample of the material (see Appendix II for details).

In the gelatins examined, the maximum ash content was found to be 3.9%; the minimum—found in an edible gelatin—was 1.1%; the average was 2.3%. The ash content of glues is higher than that of gelatins. For

example, compare the values given in Table 2 for a series of unrefined gelatin-glues, Samples Nos. 1, 3, 5, with the values for the corresponding refined gelatins, Samples Nos. 2, 4 and 6. All these samples were produced by one company.

TABLE 2

Sample No.	Manufacturer's Designation	Bloom No. (determined at 12.5% conc.)	Viscosity (mlp)	% Moisture	% Ash
1	Gelatin-glue	500	170	10.8	3.9
2	Gelatin	475	180	8.9	1.5
3	Gelatin-glue	391	135	9.7	2.8
4	Gelatin	390	130	9.1	2.2
5	Gelatin-glue	315	105	9.5	2.8
6	Gelatin	315	95	10.3	1.5

In commercial glues and gelatins where there are so many variables, such as gel strength, viscosity, pH, ash content and moisture content, it is not possible to relate the ash content to any one of these properties alone. In other words, each property is affected by all the other properties. The fact that the gel strength (Bloom Number) and viscosity are not related to the ash content alone, is shown by Table 3.

TABLE 3

Sample No.	Manufacturer's Designation	Bloom No. (determined in 6.66% conc.)	Viscosity	% Moisture	% Ash
7	Edible Gelatin	250	47.5	11.8	1.1
8	Gelatin	180	50	10.6	3.5
9	Gelatin	160	48.0	9.7	1.5
10	Technical Gelatin	125	41.5	11.8	2.0
11	Gelatin	110	39.0	11.4	1.6
12	Gelatin	100	38.5	11.3	3.5
13	Gelatin	75	25.5	10.9	1.5

In photographic gelatins the analysis of the ash is important, as even traces of impurities affect the photographic properties. In warp sizing work, an ash analysis is not of great importance unless the ash content is unusually high. The type of ash is determined by the source of the glue or gelatin and its treatment. Bone glues tend to contain more phosphates than hide glues. Chlorides and nitrates tend to lower the viscosity and gel strengths, whereas sulphates increase them. Thus, gelatins clarified by alum are apt to show an abnormally high viscosity. Zinc chloride, formerly used as a hygroscopic agent and also preservative, would lower the viscosity markedly.

Acidity or pH.—If a glue or gelatin is decidedly acid or alkaline, it may be tested by dipping pieces of red and blue litmus paper into a solution of the material. This test is not sensitive and does not distinguish between various degrees of acidity. These are best measured, usually in a 1% solution, in terms of pH by means of a hydrogen electrode. In this laboratory a quinhydrone electrode was used. Although the latter is not recommended for general use with gelatin, results were obtained which were very close to those obtained with a hydrogen electrode. In the case of light colored materials check results were also obtained with a colorimeter.

These results were in good agreement with the values given us by the manufacturers of the materials. Since the average mill does not possess adequate apparatus for measuring pH, this information can doubtless be obtained from the manufacturer.

The pH scale is from pH 1 to pH 14. The neutral point is at pH 7. Values from pH 7 to pH 14 indicate a progressively increasing alkaline solution, while values from pH 7 to pH 1 show an increasingly acid solution. Since the scale is based on a logarithmic function a difference of one pH unit indicates a 10-fold change in the concentration of the acid or alkali content of the solution.

The concensus of opinion of glue and gelatin manufacturers is that these products are most stable in solution when the pH of the solution is about 6.3; that is, slightly on the acid side. Values on the alkaline side tend to promote bacterial putrefaction of the material, especially in the case of the low grades of glues; while excessively acid pH values tend to favor hydrolysis with corresponding loss in viscosity and gel strength. Consequently, producers endeavor to get supply products whose pH in 1% solution is close to 6.3.

The glues and gelatins examined in this laboratory were all slightly acid. The most acid had a pH 5.6; the most nearly neutral sample had a pH 6.9, while the average of all the values was pH 6.28.

Returning to the question of prepared sizes, we find that in some cases the tendency to decomposition—because of the high water content—is increased markedly by the addition of materials such as sulphonated oils, which tend to make the size neutral or even slightly basic.

TABLE 4

Sample	pH
E	5.9
F	6.4
G	6.7
H	7.1

Samples G and H would be more prone to decompose than Samples E and F.

This lack of stability is overcome in part by the addition of preservatives. These occasionally lead to troubles in finishing by rendering the size less soluble. Moreover, the less stable is the size, the more preservative must be added, and consequently the greater the risk of finishing troubles. Formaldehyde used to be a notorious offender. Even very small amounts of it rendered the gelatin insoluble and almost impossible to remove. The phenol type of preservative now in use, such as cresylic acid, is not so bad, but large amounts of preservative are undesirable. It is better to start with a more stable material than to try to doctor it up later.

Water Absorption.—When allowed to stand in cold water, glues and gelatins do not dissolve but absorb many times their weight of water and swell considerably. The type of jelly formed is indicative of the grade of the sample. A gelatin having a high gel strength will form a firm jelly, while a material having a low gel strength may not form a jelly at all, but may simply give a slimy mass. The actual amount of water absorbed depends on several factors: (1) The concentration to which the solution was evaporated before it was allowed to gel, (2) pH, (3) ash content.

The details of the method used are given in Appendix III.

In the samples examined the maximum weight of water absorbed per gram of material was 20 grams, the minimum was 7 grams, and the average value 12 grams. The actual weights of water absorbed could not be correlated with the gel strength of the sample, but the firmness of the gel formed was a fair indication as to the Bloom strength of the material as given by the manufacturer.

Appendix

(*I*) *Determination of Moisture Content.*—A weighing bottle, which has a ground-glass stopper to fit, is heated for an hour at 105–110° C in an electric oven. It is allowed to cool and is then weighed. In it is placed a representative sample of one to two grams, and the bottle plus sample weighed. The bottle is then placed in the oven with the stopper removed, and heated for one hour. The bottle is stoppered, removed from the oven, allowed to cool and is then weighed. The bottle is then re-heated for an hour, cooled and weighed again. This is repeated until the weight remains practically constant

$$\frac{\text{Loss in wt. of sample}}{\text{Wt. of sample}} \times 100 = \% \text{ Moisture}$$

In order to insure a representative sample one should take portions from different places in several containers; that is, near the surface which is exposed to the air, and in the middle of the container where the material is protected from the air. These portions should be thoroughly mixed and two or more samples taken.

It is necessary to dry the sample to constant weight rather than heating for a specified length of time, because the rate of loss of moisture is dependent on the form of the sample. A finely ground sample tends to give up its moisture much more rapidly on heating than a coarse sample or one in flake form.

The weighing bottle must be kept open during heating and stoppered during cooling and weighing, otherwise it will gain enough moisture from the air during the last two operations to give erroneous results.

If the sample is heated much above 110° C, or for long periods of time, it will tend to decompose slowly and water of constitution will be driven off.

(*II*) *Determination of Ash.*—A 30 cc. porcelain crucible is heated to redness in a gas flame. It is then allowed to cool in a desiccator and weighed. This process is repeated until there is no appreciable change in weight. A sample of approximately one to two grams in size is placed in the crucible and weighed. The dry residue from the moisture determination may be used. The crucible is then heated slowly so that the sample chars and the organic matter is driven off. The sample should not be allowed to catch fire as some of the ash may be carried off by the flame. The crucible is heated to redness, allowed to cool and then weighed as before. This is repeated until the weight of crucible and ash remains constant. If the ash is dark colored, one or two drops of concentrated nitric acid may be added to the cold ash and the crucible heated to redness again.

The per cent ash is calculated on the dry weight basis; i.e., if the sample used had been previously dried in the determination, then

$$\text{the per cent ash} = \frac{\text{wt. of ash} \times 100}{\text{wt. of dry sample}}$$

If the original undried sample were used, but the moisture content had been found in a separate determination to be 11%, then

$$\text{the per cent ash} = \frac{\text{wt. of ash} \times 100}{\text{wt. of sample} \times (100 - 11)}$$

(*III*) *Determination of Moisture Absorption.*—A sample of approximately 1 to 2 grams of the original material—the air-dried material cannot be used in this test—is weighed into a small beaker. Then, exactly 50 cc. of cold distilled water are added from a burette. The beaker is covered with a watch glass to prevent evaporation, and allowed to stand for 24 hours in a refrigerator at 10° C ± 1° C. Then the excess water is poured off through a funnel, containing a small loose plug of glass wool, into an empty burette. The swollen gelatin is scraped from the beaker into the funnel and allowed to drain. When no more water drains through, the volume of the excess water is read in the burette. The weight in grams of water absorbed is simply equal to the number of cc. of water absorbed. It is expressed in terms of the weight absorbed by one gram of gelatin, calculated to an air-dry basis.

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(*Continued from page 206.*)

The dry-cleaning of wool piece goods with trichlorethylene and without the use of soap or alkali was described by Roland Derby, chemist, M. T. Stevens & Sons Co., at the meeting in Boston, Mar. 10, of the Northern New England Section of the A. A. T. C. C. The process was developed by Mr. Derby and is controlled by the Stevens Company. Mr. Derby's paper will be published in an early issue of the *American Dyestuff Reporter*.

* * *

Honorary members of the Alpha Chapter (Philadelphia Textile School) of the Phi Psi Fraternity elected at its meeting in Philadelphia March 18 were the following: Edward T. Pickard, chief, Textile Section, Bureau of Foreign and Domestic Commerce, Department of Commerce, and secretary of The Textile Foundation; Frederick M. Feiker, secretary, American Engineering Council; William McIntyre, vice-president, John Bancroft & Sons Co.; Fulton M. Farrell, wool buyer, Collins & Aikman Corp. T. B. Hayward, manager, Swift & Co., Philadelphia, was toastmaster, and the speakers were Alban Eavenson, Eavenson & Levering Co., and Mark E. Wood, assistant editor, *Textile World*.

Technical Evaluation of Textile Finishing Treatments

By E. R. SCHWARZ, F.T.I.*

This is the first of a series of research progress reports by Prof. E. R. Schwarz on the "Technical Evaluation of Textile Finishing Treatments" that is being sponsored jointly through a co-operative research agreement between Massachusetts Institute of Technology and the American Association of Textile Chemists and Colorists. The A. A. T. C. C. is providing the funds so that M. I. T. can assign some of their personnel and equipment to the study of this problem. We note an increasing interest in the subject from both textile producers and textile consumers. A general idea of the scope of the work and a more specific approach to the question of stiffness in fabrics is discussed here, together with a bibliography covering important work by others in this field.—K. H. BARNARD, *Chairman, Sub-committee of A. A. T. C. C. on Permanent Finishes.*

Introduction

FABRICS as they come from the loom are seldom in a state suitable for use or of such appearance or feel as to be pleasing to the ultimate consumer. For this reason, finishing treatments of greater or less complexity must be employed in order to produce satisfactory material. Just when in the sequence of finishing operations a satisfactory finish is obtained is therefore an important decision and rests now largely on the judgment of one or more individuals rather than upon scientific measurement or combinations of the two.

It has been stated by Binns[a] that the advantage of judgment in certain circumstances lies in the fact that the central organ of mind and the senses are able to correlate automatically the numerous factors of a fluctuating situation and to do it with an accuracy not readily obtainable by scientific methods. One difficulty with judgment in the absence of technical data is the diversity of descriptive terminology employed. For example, consider this instance: As a result of certain visual and tactile tests on a series of worsted fabrics, the judges employed the terms: smart, level, clear, well-covered, even, smooth, bright, homogeneous, compact, well-rounded, balanced, "rawky," rough, irregular, streaky, "grins," knoppy, crepey,

* Professor of Textile Technology, Massachusetts Institute of Technology, Cambridge, Mass.

[a] Binns, H. "Psychological Investigations of the Influence of Various Methods of Manufacturing Worsted Yarns on Cloths." *J. T. I.*, Mar. 1934, P. T89.

rubbed-up, clumsy, cockly, thin, flannely, solid, sharp, stripey evenly-balanced, and lustrous, to report visual findings. The same group used the terms: silky, soft, full, kind, firm, pliable, tight, solid, well-bedded, mellow, velvety, rich, elastic, sticky, loose, springy, lofty, boardy, weighty, foody, warm, tapery, drapes well, cottony, lumpy, dead, and leathery, to describe their tactile impressions.

If "handle" of a cloth is to be described in any such erratic fashion, there would definitely appear to be room for experimental investigation of what may turn out to be correlated scientific measurements.

Handle

A property common to fibre, yarn, and fabric alike is known familiarly in the textile trade as "handle" or "hand." This property is judged as a function of the *feel* of the material and the sensation, of stiffness or limpness, hardness or softness, and roughness or smoothness, all contribute. Physical tests which would analyze and reflect the senations felt and which would assign numerical values to these measurements are very desirable. Peirce,[12] in an article entitled "The 'Handle' of Cloth as a Measurable Quantity," discusses various tests for determining the stiffness factor of fabrics and of yarns. Reference will be made in further detail to this work in the following considerations.

Flexibility.—Ease with which a specimen may be bent or twisted can be stated as the *flexibility* of the material. This is to be distinguished from *rigidity*, which is a measure of the resistance offered by the sample to bending or to twisting. In the former case it is known as flexural rigidity and in the latter as torsional rigidity. The rigidity, when related to the resistance to bending, is a measure of the stiffness. Whether we consider flexibility or rigidity in bending or in twisting, there are two approaches to the problem. The first is concerned with measurements of deformation and the second with measurements of the forces producing the deformations. Thus, all tests of these factors may be grouped into two large classes depending upon whether deformation is measured or whether force is measured. It is also possible to calssify the tests in the first group by noting the axis of deformation. Specimens may be bent about a horizontal axis or about a vertical axis. They may also be twisted about a central axis or about an axis which does not coincide with the center line of the specimen itself. This latter instance takes place in the twisting of fibres into yarns or of single yarns into plied construction, while the former instance is noted in the twisting of individual filaments as they are placed in yarns—particularly when they are long enough so that the twist insertion or removal in the yarn itself has full opportunity to act upon the individual filament, as in the case of rayon or silk.

In connection with any of the investigations of bending, it is necessary to take into account the weight of the specimen itself or else to so design the test method as to correct for or eliminate the weight of the specimen. It is possible, then, to determine the deformations which take place in a specimen which is allowed to deform with no forces other than its own weight acting or to apply definite forces to produce a deformation and measure both.

Measurement of Deformation

Bending About a Horizontal Axis.—Four types of tests may be distinguished as falling under this heading: (1) The cantilever test in which a specimen is supported in an initially horizontal position at one end only; (2) the hanging strip test in which the specimen is supported at one end only and hangs vertically; (3) the ordinary beam test in which the specimen is supported in an initially horizontal position at both ends; (4) the hanging loop test in which the specimen is distorted into any one of several shapes of loop, supported at one point and hanging vertically.

(1) The empirical study of the cantilever test in many of its ramifications is covered in a paper by Peirce [12] and in its theoretical mathematical implications in a paper by Bickley.[5] For the purpose of mathematical discussion, the specimen is assumed to be a uniform thin lamina in which the curvature is proportional to the bending moment. If the bending moment and the weight per unit area are known, the immediate object of the test is to evaluate the ratio between these two quantities in terms of the overhanging length of the specimen and the angular deflection of the end of the strip. Experiments with specimens of various shapes, including the rectangle, triangle, and semi-circle, lead to rational formulas in terms of the bending length, so-called. This is the length of fabric which will bend of its own weight to a definite extent.

For the rectangular cantilever, the formula for bending length is

$$c = l(\cos 0.5\theta/8 \tan \theta)^{1/3}$$

For the triangular cantilever:

$$c = l(0.6933)(\cos 0.5\theta/8 \tan \theta)^{1/3}$$

For the semi-circular cantilever,

$$c = l(\cos 0.5\theta/8 \tan \theta)^{1/3}[f(l/r)]$$

where "r" is the radius of the specimen.

In each case values of $(\cos 0.5\theta/8 \tan \theta)^{1/3}$ are conveniently available in tabular form, as are the values of $f(l/r)$. This latter function is a complicated trigonometric relationship, involving the cos Ω which equals $1 - l/r$.

The rectangular shape is of wide application, but for extremely flexible fabrics the triangular shape (point outermost) is more satisfactory. One difficulty with the method as a whole is the fact that certain specimens show decided tendency to curl. In this case, the trouble may be minimized by the use of the semi-circular specimen. On the other hand, certain fabrics are stiffer than can conveniently be handled by any of the methods described. In this case, it is possible to weight the end of the specimen and to alter the formula to take this loading into account. The expression becomes more complex, but is not too difficult if a simple modification is made by the justified assumption that one of the ratios involved is substantially constant at 20. Thus, if W is taken to represent the weight added to the end of the cantilever, and b = width of sample, we have:

$$c = l(\cos \theta/\tan \theta)(0.336W/bl + 0.131)^{1/3}$$

Given the stiffness in warpwise and fillingwise directions, it is possible

to compute the stiffness in any desired direction. Here

$$c = c_1(\cos^2 \alpha + k^2 \sin^2 \alpha)^{-2/3}$$

where

$$k = (c_1/c_2)^{3/4}$$

and the mean value is given with a good degree of precision by

$$\bar{c} = \sqrt{c_1 \cdot c_2}$$

Peirce [12] further points out additional measurements which contribute to a knowledge of "handle." He lists the *flexural rigidity* which is a measure of the resistance to bending and indicates something of the sensation experienced when a piece of fabric is bent between the fingers. It may be evaluated as the product of the weight per unit area of the fabric and the cube of the bending length.

Thickness must also be determined and the approved method in this country is that developed at the Bureau of Standards by Schiefer.[b] The *bending modulus* is valuable since it differs from rigidity in being independent of the dimensions of the specimen. For textiles, it may be considered as a measure of compactness and varies with the degree of adhesion of fibres and yarns. It is most conveniently computed by correcting the rigidity for thickness as,

$$q = 12G/d^3(10^6) \text{ kgm/cm}^3$$

Still another modulus is the *modulus of compression*, h. This is also a measure of the hardness of the material in a direction at right angles to the surface,

$$k = (P_1 - P_2)/(d_1 - d_2)$$

Hardness measured by the modulus of compression is therefore the difference in thicknesses existing respectively under each pressure. Two remaining measures are *density* (weight per square centimeter divided by the thickness in centimeters) and the *extensibility* (obtained from the usual tensile test by the strip method).

Just how these various quantities should be combined to give a value which will correlate with the judgment of the appraiser using unaided hand and eye is yet to be determined. It is hoped that the present investigation may assist in solving this problem.

The cantilever test requires apparatus which takes the form of a clamp supported in trunnion bearings so that the axis of bending is in the plane of the front edges of the clamp. A platform (often equipped with a pointer), graduated along its length with a convenient scale, is similarly pivoted about the same axis. Thus, the angular deflection of the end of the cantilever can be measured by noting the position of the platform (or pointer) on a curved scale graduated in degrees.

(2) Of considerable interest and importance is the measurement of flexibility (bending length) which can be obtained according to Peirce [13] from a study of the dimensions of a distorted loop. This is the *hanging loop* technique. A specimen of known width and length (L) is formed into a heart-shaped or pear-shaped loop and suspended from a horizontal bar.

[b] Schiefer, H. F. The Compressometer. Bur. Stds. Jl. Res., June, 1933, p. 705.

Using any desired measuring device ranging from a simple scale to a cathetometer, the distance from the point of suspension to the bottom of the loop may be measured. The bending length formulas are—

$$c = l_0 f_2\theta \text{ for the heart loop}$$
$$c = L(0.133)f_2\theta/\cos 0.87\theta \text{ for the pear loop}$$

where $f_2\theta = (\cos\theta/\tan\theta)^{1/2}$

$l_0 = 0.1337L$ heart loop

$l_0 = 0.4243L$ pear loop

and $d = l - l_0$

$\theta = 32.83d/l_0$ heart loop

$\theta = 504.5d/l_0$ pear loop

(3) Hall [10] suggests placing a specimen horizontally on a smooth surface such as glass, against a co-ordinate ruled background. The specimen is then formed into a self-supporting inverted "U" shaped arch which can be measured against the co-ordinates. In the same manner Grimshaw [7] suggests that stiffness of fabrics might be measured by determining the comparative sag of samples held between jaws horizontally and pulled out to various lengths.

(4) Smith-Taber [28, 29] has developed an instrument for measuring the stiffness of materials including fabrics which supports the specimen vertically by means of a clamp at the upper end. The clamp is arranged in conjunction with a graduated disk so that indicator mechanisms provide a singnal as soon as the specimen has bent through a standard angle of 22.5 degrees, and the amount of rotation of the disk can be measured to indicate relative stiffnesses.

Bending About a Vertical Axis

A test for bending deformation about a vertical axis is a drape tester designed by Bellinson at the M. I. T. Textile Research Laboratory. In this device a fabric specimen of desired length and width is suspended vertically with its upper edge secured closely in contact with the periphery of a horizontal disk of semi-circumference equal to the width of the specimen. The disk is adjustable as to height of support so that the bottom edge of the specimen just grazes the surface of a base on which is drawn a circle of diameter equal to the diameter of the disk and concentric with it. Tangent to the circle is drawn a straight line and two perpendiculars are erected to this line which are also tangent to the circle. If the fabric is entirely flexible and uniformly so, the bottom edge of the specimen will form a semi-circle matching one-half of the base circle. The stiffer the fabric, the more nearly the bottom edge will approach a straight line. When the fabric falls between these two forms, the intercept of the edge with th vertical tangents is noted. The distance from the base line to the intercept is divided by the length of the respective tangent measured from the base line to the point of tangency with the circle. Another method of using the device in the case of a stiff fabric is to shorten the length of the specimen progressively until the lower edge shows a definite degree of departure from a straight line. The length of sample is then an inverse measure of the stiffness.

Measurement of Deforming Force

The second classification of flexibility tests is concerned with the measurement of force rather than deformation.

Bending about a Horizontal Axis.—(1) The first type to be treated is the *cantilever*. The specimen may take the shape of a flat strip or a loop and is held at one end in a rotatable clamp, the degree of rotation of which can be read on a scale. The other end is allowed to rest on one pan of a balance. If now the specimen is pressed against the balance pan by rotating the clamp, the force necessary to restore the unclamped end to its original position is measured. Such a device is described by Saxl.[23] Durst [8] describes a somewhat similar scheme, except that the specimen is clamped at one end, bent into a "U" shaped spring and allowed to press against a balance pan.

(2) Vertical strips and loops can be tested in a device developed by Gurley.[9] Here the specimen is clamped at its upper end to a rotating arm, and is drawn across the endge of a horizontally pivoted vane. The deflection of the vane can be measured at the instant that the specimen slips off of it. As modified in the Textile Research Laboratory at M. I. T., the clamping arm moves against a scale allowing the angular displacement of the upper end of the specimen to be measured as well. If certain known weights are placed at specified points on the vane support, the angular displacement of the vane can be converted to milligrams force necessary to produce the deflection by reference to a table.

(3) Munzinger [11] advocates the use of a modified ballistic pendulum. In this device the specimen is supported at its lower end and extends up vertically into the path of a swinging pendulum. The distance which the pendulum swings beyond its lowest point without a specimen in place is compared with the distance it swings after bending the specimen in the course of its passage. The difference in energy was absorbed by the specimen in bending and is a measure of stiffness.

Bending about a Vertical Axis.—(1) When bending takes place about a vertical axis, it is usual to support both ends of the specimen if the deforming force is to be measured. An instrument designed in this manner was developed by Schiefer [24] and embodies the unique feature of testing two samples in opposition. Each specimen is rectangular in shape and is supported at one end by cementing to a clip which can be attached to the outer edge of a movable vane. The other end is similarly attached to the outer end of a fixed vane. The rotating vanes are attached at their inner edges to a vertical, central axis. Two vanes are fixed against rotation, while two are rotatable in such fashion as to fold the specimens between themselves and the fixed radial vanes. A pointer reading against a circular scale gives the angular rotation of the vanes. Rotation is brought about by means of either a cantilever or a spiral spring, the deflection of which is readable on a second circular scale. Provision is made for calibration of the spring by means of dead weights, and after calibration, the stress acting to deform the specimens is read from a table or chart. Both folding and unfolding can be carried out in as many cycles as desired so that hysteresis effects can be investigated conveniently. The energy required to fold a sample of fabric is a measure of its stiffness and the recoverable energy expressed as a percentage of the energy input is a measure of its resilience. The energy which is lost when a sample is folded is dissipated in producing a crease

in the fabric. The angle to which the fabric is folded and the time it is allowed to remain folded, as well as the dimensions of the sample are important factors. In order to obtain comparable results the angle to which the sample must be folded as a limit depends upon the thickness of the specimen. An equation for determining the minimum angle for any given thickness of fabric is given as

$$\beta = 430d$$

where β is angle in degrees
and d is thickness of sample in inches.

(2) Torsion pendulums may also be employed for measuring the forces necessary to bend a fabric about a vertical axis. Here two pendulums are arranged to hold both ends of a rectangular strip of fabric. Each pendulum is suspended by a long, fine filament, and is of known moment of inertia. These moments are substantially equal for the pendulums as is the period of oscillation in torsion when unrestrained. If now a specimen is supported between the pendulums and they are started in rotation in opposite directions, the period of oscillation will be a function of the flexural rigidity.

$$\text{Flexural rigidity} = 2\pi^2 I_p(l/\tau^2) = f(1/\tau^2)$$

So that if the reciprocal of the square of the average period for one sample is compared with a similar quantity for another sample (pendulum system and size of specimen remaining constant throughout), the flexural rigidities will be in similar relationship. This method has been used by Peirce[13] to test starch films and is probably adaptable to fabric as well.

Factors Causing Variations

In carrying out flexibility tests, two sets of factors which cause variation in results must be considered. One set is made up of external conditions and includes moisture regain, rate of load application or rate of deformation, and curvature or distortion of the specimen in mounting. Moisture regain has a very decided influence upon the results of test by any method and it has been found that regardless of the kind of fibre composing the material tested, an increase of moisture regain produces an increase in flexibility. It may eventually be possible to establish correction data so that flexibility measured under any existing moisture condition can be corrected to any other desired or standard condition. Whether the standard condition should be one of substantial equilibrium with a standard atmosphere, or whether it should be worked out on the basis of a constant moisture regain is a matter for eventual decision.

All textile materials are essentially plastic in their properties of deformation, hence the time rate of loading or deforming must be carefully studied and controlled. Not only the conditions during the actual tests should be under control, but the rest periods both as to duration and as to location in the cycles of tests must be carefully worked out. There is evidence to point to the likelihood that fibres obey some form of "memory law," such that for a certain time after a distortion, they remember the distortion and during this time further distortions will be affected by the

previous treatment. Unless great care is exercised, it is obvious that results may be erroneously interpreted or be impossible of interpretation.

Results of flexibility tests may be seriously affected by distortion of the specimen in setting it up in the instrument used. This may be demonstrated readily by holding a sheet of paper horizontally between the fingers, grasping it at one end. If the end which is held is straight, the paper will droop into a characteristic flexing curve. If, however, the edge held in the fingers is curved even the slightest amount, the flexing curve is considerably altered. By producing a sufficient degree of curvature of the supported edge of the paper, it will be found that no flexing will occur in the sheet under its own weight, and that furthermore, a considerable pressure must be exerted to cause deflection.

The factors are also to be considered which are inherent to the specimen itself. Finish, thickness, weight, yarn waviness, fibre composition, skewed yarns, and bow all contribute variable amounts to the difficulty of a precise measurement. If the result of finishing operations is to be investigated, as is proposed in this work, it is obvious that all the other items of internal variation must be controlled, eliminated, or corrected for.

Literature Review

For the purpose of additional background in this project it is proposed to survey the methods now in use in the praper industry for the measurement of stiffness of paper, and to review the published material relating to the exercise of judgment through the sense of touch in grading fabrics as to quality. The results of these surveys will be published shortly.

Experimental

For the experimental work a fabric which has been finished by a routine which has produced a satisfactory material will be compared with the unfinished fabric by the hanging loop technique, the cantilever test, the Gurley Vane test, the Schiefer Flaxometer test, the Bellinson drape test, the Searle pendulum test and the Munzinger Impact test. Additional fabrics will be subjected to a similar series of investigations, the materials selected in each case to furnish a reasonable range of thickness, stiffness and weight. It is also hoped that a series of tests may be arranged to grade a range of fabrics manually for flexibility and for handle in general, and to initiate a program, the object of which will be to establish any correlation between the manual and the technical tests which may be discovered.

Work is already underway on the test methods noted above with the exception of the last two. These instruments are under design and will be constructed and employed as soon as possible. Work is conducted in a constant temperature and humidity laboratory and advice from a staff member specializing in the field of textile plasticity is available in connection with details of procedure. Adequate statistical analysis of data, and precision planning of experiments and sampling will be employed throughout.

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(*Continued on page 230.*)

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(*Continued from page 229.*)

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Milk-Wool (Lanital): Resistance of—to Micro-organisms and Moths. W. H. Glover. *Nature*, 1938, V. 141, P. 1057; abs. in *J. Soc. Dyers Col.*, Aug. 1938, P. 396.

According to communications from Snia-Viscosa, Milan, and Comm. Ferretti, manufacturers and inventor respectively of Lanital, no case of attack of this fibre by micro-organisms has been noted during the period in which it has been in commercial use. Moreover, it is stated that Lanital is not attacked by moths. (C)

New Fibres and Rumors of Fibres. F. G. Brown. *Text. Col.*, Nov. 1938, P. 731–3. (C)

Nitrogenous Rayons and Protein Fibres: Europe's Progress in Producing. Paul Wengraf. *Rayon Tex. Mo.*, Dec. 1938, P. 60–1, 96. (C)

Protein Filaments: Preparation. J. F. Tournier. *Rusta*, 1938, V. 13, P. 17–21; abs. in *J. T. I.*, July 1938, P. A387.

The denaturation of proteins and the production of artificial fibres by spinning solutions of the denatured products are discussed. Suitable sol-

vents comprise aqueous solutions of urea, thiourea, formaldehyde, sodium salicylate, acetamide, etc. These solutions both dissolve and denature protein materials. Protective colloids and dispersing agents may be added. The protein solution is allowed to ripen until the desired viscosity is reached and is spun into a bath containing ammonium sulphate, sodium sulphite, sulphuric or acetic acid or zinc chloride or other suitable materials. The filaments may be after-treated with aqueous solutions of formaldehyde, alum, potassium dichromate, tannic acid, etc., to increase their strength and with solutions of wax in order to improve their pliability. Details are given of procedures for the preparation of filaments from peanut and castor-oil seed globulins and casein. (C)

RAYON: SOME ASPECTS OF THE PRESENT AND FUTURE DEVELOPMENT OF. Julian Warwick. *Text. Col.*, Nov. 1938, P. 743–6. (C)

STAPLE FIBRE: MANUFACTURE OF—BY THE KOHORN SYSTEM. H. H. Von Kohorn. *Rayon Tex. Mo.*, Sept. 1938, P. 85–7. (C)

VISCOSE RAYON: EFFECTS OF SPINNING CONDITIONS ON THREAD TENSION AND STRENGTH. T. Tomonari. *J. Cellulose Inst. Tokyo*, 1937, V. 13, P. 33–45; abs. in *J. T. I.*, July 1938, P. A388. (C)

"TECA" STAPLE FIBRE. Tennessee Eastman Corp. *Rayon Tex. Mo.*, 1938, V. 19, P. 242.

"Teca" staple fibre is a cellulose acetate staple fibre having a permanent crimp. Yarns and fabrics made from it have a wool-like handle and are resistant to crushing and creasing. The fibre is dyed with the usual cellulose acetate dyes and is usually dyed in the "top" form. It is available in lengths of ¾ to 9 inches and in deniers of 16 to 20. The number of crimps varies with the fineness and corresponds to those commonly found in wool of similar diameter. (C)

II. YARNS AND FABRICS

DENIER OF STAPLE FIBRE AND ITS PRACTICAL EVALUATION BY COUNT AND CALCULATION: UNIFORMITY OF. PART II. E. Husung. *Mell. Textilber.*, 1938, No. 12, P. 956.

The first part of this article dealt with the measuring processes at disposal for the investigation of the uniformity of denier of staple fibre, and this second part shows the practical application of the methods derived from the theory of the first part. The analysis of frequency diagrams is discussed in detail. The probability and frequency ruled paper devised by A. Beckel and K. Daeves was made use of for plotting these diagrams. This method permits of analyzing mixtures of staple fibre, even when there is no difference in the lengths into which it has been cut. Numerous illustrations facilitate the understanding of the work described. (C)

FABRICS IN THE FILM INDUSTRY. *Linen Trade Circ.*, 1938, V. 24, No. 1281, P. 3; abs. in *J. T. I.*, Sept. 1938, P. A532.

The field for fabrics in the film industry is likely to expand if plants for technicolor production are developed. The picture industry looks to manufacturers to demonstrate that suitable fabrics can be produced for color-film work. The chief requirements will be that such materials will translate themselves into pleasing tone effects when filmed. (C)

FABRICS: CREASE-RESISTANCE. J. Auerbach. *Mell. Textilber.*, 1938, V. 19, P. 512–5; abs. in *J. T. I.*, Oct. 1938, P. A618.

The creasing of textile fibres, the differences in resistance to creasing shown by the different types of fibre, the factors determining the extent of creasing, and the influence of the structure, fineness, fibre length and other properties of rayon and staple fibre on resistance to creasing are discussed. It is pointed out that the resistance of fabrics to creasing varies with the type of yarn and the weave used, with the thickness of the fabric, the treatment it has received in finishing, etc., and that knitted fabrics in general show better resistance to creasing than woven fabrics. The method of increasing the resistance of textile materials to creasing by impregnating with synthetic resins according to the I. G. Farbenindustrie A.-G. and Tootal Broadhurst Lee Co. patents is described and the suitability of the different types of fibres for treatment in this way is discussed. The effects of the treatment on the strength, swelling, shrinking and other properties of rayon and staple fibre are briefly described. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

WETTING AGENTS IN TEXTILE PROCESSING. PART III.—CALCIUM SOAP DISPERSING POWER. S. R. Ramachandran, I. S. Uppal, and K. Venkataraman. *J. Soc. Dyers Col.*, Nov. 1938, P. 520–6. (C)

WOOL: DETERMINATION OF ACID IN. J. Barritt, H. H. Bowen, F. L. Goodall and A. Whitehead. *J. Soc. Dyers Col.*, Dec. 1938, P. 566–73.

An examination of three of the methods in general use for the determination of acid in wool has been carried out in each of four independent laboratories. In initial experiments the sodium terephthalate method was found to give lower acid values than those obtained by either the sodium acetate or the pyridine method. Since it did not appear possible that the pyridine method could return more acid than is actually present, work on the sodium terephthalate method was not pursued. The results obtained by the sodium acetate distillation method were irregular and the method is influenced appreciably by a large blank correction which was found to be erratic. The results obtained by the four investigators by the pyridine method on commercially dyed cloth and laboratory acid-prepared cloth agreed well. Work was therefore directed to an examination of possible defects in the method, such as (1) degree of recovery of acid present; (2) degree of recovery of acid from wool, whether dried at low or high temperatures, is almost complete (of the order of 90 to 100%)

under conditions as originally described; *i.e.*, the sample is thoroughly wetted out in 0.5% pyridine (100 cc. per 1 g. of wool) and allowed to stand for 1 hr. at room temperature. The difficulty of determining the end-point of the titration in red or violet liquors with phenolphthalein as indicator may be overcome by substituting Thymol Blue for phenolphthalein. (C)

WOOL: MEASURES FOR PREVENTING THE DESTRUCTION OF—IN TEXTILE PROCESSING. J. Wakelin. *Am. Dye. Rptr.*, Nov. 14, 1938, P. 654–6. (C)

WOOL-STAPLE FIBRE YARNS: DYEING. W. Hahn. *Mell. Textilber.*, 1938, V. 19, P. 437–8; abs. in *J. T. I.*, Aug. 1938, P. A484. (C)

WOOL: BLEACHING OF—WITH SULPHUR DIOXIDE AND WITH SOLUTIONS OF SULPHITES. H. Phillips. *J. Soc. Dyers Col.*, Nov. 1938, P. 503–12.

The author's summary is as follows: (1) When wool is bleached with sulphur dioxide or with solutions of sulphites, the disulphide groups react with sodium bisulphite and thiol and *S*-cysteinesulphonate groups are produced in the wool. (2) The total sulphite in bleached wool can be determined as sulphur dioxide by distilling the wool with a dilute solution of phosphoric acid, pH 2.0–3.5. The "free" sulphite can be determined by distilling the wool with concentrated hydrochloric acid. The organically combined sulphite, present as *S*-cysteinesulphonate groups, is given by the difference between the total and the free sulphite in the wool. (3) A measure of the sulphate content of sulphite bleached wool is obtained by determining the sulphate in the hydrolysate of the wool and subtracting that produced in the hydrolysis by the decomposition of the *S*-cysteinesulphonate groups. (4) The yellowish tint of clean wool may be due to the chromophoric character of some at least of the disulphide groups, and bisulphites bleach wool by reacting with these groups. Thanks are due to the Council of the Wool Industries Research Association for permission to publish this paper and to Dr. E. N. Dodd for assistance in some of the experimental work. (C)

WOOL: NEUTRAL DYEING AND ITS HARMFUL EFFECT ON. J. B. Speakman and C. E. Coke. *J. Soc. Dyers Col.*, Dec. 1938, P. 563–65.

The neutral dyeing of wool, *i.e.*, the method of dyeing with colloidal dyes from a bath containing sodium sulphate only as the assistant, is regarded by practical dyers as being more harmful in its action on wool than acid dyeing. With a view to discovering the cause of this defect, the action of sodium sulphate solution on unstrained fibres at the boil, and on strained fibres at different temperatures, has been investigated. In all cases, however, sodium sulphate solution was found to be less harmful in its action on animal fibres than distilled water under similar conditions. (C)

IV. Research Methods and Apparatus

Acidity in Knitted Wool Goods: Determination of. S. R. Trotman and A. Bramley. *Analyst*, 1938, V. 63, P. 405–10; abs. in *J. T. I.*, Sept. 1938, P. A554.

Various methods are discussed and three methods: (1) extraction with pyridine, (2) distillation with sodium acetate and (3) a new method, extraction with borax, are examined in detail. In the borax method, the sample (1–2 gr.) is soaked in 50 cc. 0.2 N borax for six hours. The liquor is filtered through glass wool and wool washed ten times with water. The filtrate and washings are titrated with 0.2 N hydrochloric acid, using methyl red as an indicator. The authors conclude from a series of determinations using the three methods that for large acid concentrations the pyridine method does not remove the whole of the acid present. The effect of storage and drying at high temperatures on the acid control of wool is examined. Sulphurous acid may be determined by distilling into hydrogen peroxide and determining the sulphuric acid formed. (C)

Bibliography of Textile Test Methods. Harry A. Mereness. *Rayon Tex. Mo.*, 1938, May, P. 42–4; June, 42–4.

The author, who is director of technical research, National Federation of Textiles, has prepared a very comprehensive list by groups and subjects that enhances their value for reference purposes. He does not claim the list to be complete, but to contain the most important methods. They are listed as official, semi-official and unofficial, and under the latter title are given methods on which most information is available and which are most likely to become official. The bibliography has been reprinted in booklet form. (C)

Canvas Disc Wetting Test. H. Seyferth and O. M. Morgan. *Am. Dye. Rptr.*, Sept. 19, 1938, P. 525–32; reprinted from *Dyestuffs*, Sept. 1938.

The canvas disc wetting test is discussed and compared with the official method of the A. A. T. C. C. The canvas disc wetting test is of great practical value as an alternate to the present official method, due to the much shorter testing time involved, the ease of procuring data at low concentrations of surface active agents as are used in mill operations, and the easy availability of testing supplies and apparatus. Wetting data by both methods are presented for five currently used surface active agents at three temperatures and five concentrations. (C)

Constant-tension Rod-wrapping Apparatus. W. Weltzien, K. Werner and E. Husung. *Monatsh. Seide u. Kunstseide*, 1937, V. 42, P. 437–41; abs. in *J. T. I.*, July 1938, P. A427.

Full details are given, with illustrations, of an apparatus for preparing the wrappings of yarn on rods of suitable diameters for the "shrinkage diagram" and "re-dyeing" tests developed by the B. C. I. R. A. for the examination of mercerized yarn. The apparatus is designed to wind the yarn under constant tension and unwind it without tension. It is pointed out that a wrapping of rayon thread on a rod of 9 cm. circumference when

cut lengthwise provides a number of 9-cm. lengths the weights of which can be translated directly into deniers. (C)

COTTON FABRIC DEFECTS REVEALED BY THE MICROSCOPE. Walter G. Kramer. *Text. Wld.*, Aug. 1938, P. 61–3.

The accompanying illustrations show the way in which microscopic examinations reveal the differences between normal and defective fibres, yarns, and fabrics. (C)

DAMAGED SILK: VISCOSITY TEST. A. S. Tweedie. *Canadian J. Rsch.*, 1938, V. 16, P. 134–50; abs. in *J. T. I.*, July 1938, P. A426.

Trotman and Bell's method for the detection of damage in silk by measuring the viscosity of its solution in aqueous zinc chloride has been further investigated, and the results are described. (C)

DAMAGED VISCOSE RAYON AND STAPLE FIBRE: MICROSCOPICAL EXAMINATION. W. Köhler. *Kunstseide*, 1938, V. 20, P. 158–63; abs. in *J. T. I.*, Aug. 1938, P. A499. (C)

DENIER OF STAPLE FIBRE AND ITS PRACTICAL EVALUATION BY FIGURES AND GRAPHS: INVESTIGATION OF UNIFORMITY OF. E. Husung. *Mell. Textilber.*, 1938, No. 11, P. 886–89.

No recording apparatus has hitherto been designed for the determination of uniformity of the titre of the fibres of wool or staple fibre and recourse was consequently had to tedious methods of investigation. The methods adopted were, firstly, determination of the titre by weight and, secondly, determination of single titres by measuring the magnified cross-section surfaces. Very sensitive balances are required for the first method and the rapid-damping torsion type has proved satisfactory for the purpose. The process of weighing individual fibres must be very carefully carried out. The staple cutting apparatus designed by Messrs. Zweigle, Reutlingen, is recommended for the preparation of fibres of equal length. Determination of the titre of individual fibres by measuring the magnified surface of a cross-section is always practicable, provided that magnification is sufficiently high. One of the familiar rapid processes may be used for preparing the cross-sections. There are three methods of statistically treating the evaluation of the results of these measurements: firstly, purely by calculation (mean value and scatter), secondly, by the use of graphs, and finally, by combining these two methods. All three methods are described in detail in the present article. (C)

V. PURE SCIENCE, ECONOMICS AND MISC.

HIGHLY POLYMERIZED COMPOUNDS: VISCOSITY STUDIES ON CELLULOSE NITRATES. H. Staudinger and M. Sorkin. *Ber. deut. chem. Ges.*, 1937, V. 70, No. 12, P. 2518; abs. in *Eastman Kodak Bull.*, Sept. 1938, P. 424.

The formula for the viscosity law is $\frac{\eta_{sp}}{c_{gm}} = K_m.M$, where η_{sp} is the specific viscosity, c_{gm} is the concentration in moles of monomer per liter of

solution, K_m is a constant, and M is the molecular weight of the polymer. Or, the formula may be written: $\frac{\eta_{sp}}{c} = K_m.P$, where c is the concentration in grams per liter of solution and P is the degree of polymerization. The use of the two concentration terms in a previous communication by the authors (see *Ibid.*, 1937, V. 70, P. 1993) is clarified. (S)

HOMOGENEITY AND PROPERTIES OF NITROCELLULOSE. H. M. Spurlin. *Ind. Eng. Chem.*, May 1938, V. 30, P. 538–42; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

A sample of nitrocellulose was systematically fractionated by precipitation with heptane from acetone solution. Stress-strain curves and fold resistance were determined on films from such fractions. Results were compared with those from unfractionated nitrocellulose and from blends of high- and low-viscosity nitrocellulose, which were selected to have the same range of viscosities as the fractions. For each group of materials, a definite relation was found to exist between viscosity and Schopper fold resistance. There was a sharp limit of viscosity below which the product did not withstand folding. The fractions had higher fold values than unfractionated material of the same viscosity, and this, in turn, was better than blends of high- and low-viscosity nitrocellulose. These examples, based on the sensitive fold test, show that physical properties are a function of homogeneity, other factors being constant. (S)

MICROPHOTOGRAPHY: VERY SIMPLE METHOD OF. R. Teunissen. *Focus*, 1937, V. 24, No. 26, P. 728–29; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

Photomicrographs are made by placing the photographic film in a small frame which rests directly on the upper end of the microscope tube from which the ocular has been removed. (S)

MINIMUM PERCEPTIBLE COLORIMETRIC PURITY AS A FUNCTION OF DOMINANT WAVE LENGTH. I. G. Priest and F. G. Brickwedde. *J. Research Bur. Standards*, May 1938, V. 20, P. 673–82; abs. in *Eastman Kodak Bull.*, Sept. 1938, P. 420–1.

A 4°-square, two-part photometric field, symmetrical about a vertical division and viewed through a pupil 3 mm. in diameter, is illuminated in both parts by artificial sunlight at a constant brightness of about 3 or 4 millilamberts (retinal illumination, 70 to 90 photons) with a surrounding field of about 0.5 millilambert. Homogeneous light is added to one half, and sunlight simultaneously subtracted so that the field remains matched in brightness. Two adjustments of the mixture are made: (1) The least purity perceptible with certainty (p_{max}), and (2) the greatest imperceptible purity (p_{min}). The purity of these mixtures is then measured, increased accuracy being obtained by measuring a known large multiple of the homogeneous brightness. Values of p_{max} and p_{min} have been obtained as a function of the wave length of the homogeneous component; these values are reported in detail, and some discussion of their interpretation is given. (S)

PHOTOELECTRIC MEASUREMENTS OF THE SEASONAL VARIETY IN DAYLIGHT AROUND 0.41 μ, FROM 1930 TO 1937. W. R. G. Atkins. *Proc. Roy. Soc. (London)*, 1938, V. 165A, No. 923, P. 453–64; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938. (S)

STABILIZATION OF COLOR IN THE DETERMINATION OF HISTIDINE BY THE DIAZO METHOD AND ARGININE BY WEBER'S METHOD (SAKAGUCHI REACTION). L. E. Thomas. *J. Biol. Chem.*, May 1938, V. 123, P. cxxi–cxxii; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

When the amino acids, histidine and arginine, are precipitated as mercuric salts, and used for the diazo and Weber color reactions, respectively, it is found that much more stable colors are formed. (S)

(TEXTILE) LABOR PRODUCTIVITY. Boris Stern. *Tex. Wld.*, April 1938, P. 68–9.

An abstract of reports of a study of the U. S. Bureau of Labor Statistics, in co-operation with the National Research project of the W. P. A., on the results of mechanical changes in the woolen, worsted and cotton industries. The collected data were prepared in collaboration with Barnes Textile Associates, and summarized by Boris Stern in the August, 1937, and January, 1938, issues of the *Monthly Labor Review*. The reports show the increase in man-hour output of several types of cotton, woolen, and worsted fabrics made possible by mechanical changes which occurred between 1910 and 1936; also the amount of improvement which has taken place in the various manufacturing departments. (C)

TEXTILE WASTE DISPOSAL. AN ORDERLY APPROACH TO THE PROBLEM. L. L. Hedgepeth and C. B. Griffin, Jr. *Am. Dye. Rptr.*, June 27, 1938, P. 342–4.

Address before Philadelphia Section, A. A. T. C. C., March 4, 1938. (C).

THIOL AND DISULFIDE COMPOUNDS: DETERMINATION OF—WITH SPECIAL REFERENCE TO CYSTEINE AND CYSTINE. K. Shinohara. *J. Biol. Chem.*, Sept. 1937, P. 743–9; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

The use of A-phosphor-18-tungstic acid as an oxidizing agent for the determination of cysteine may give erroneous results, depending upon the ratio of cysteine and reagent. In the presence of an excess of reagent, the A-phosphor-18-tungstic acid loses its equivalent of oxygen per molecule of cysteine, which is thereby converted to cystine. When, however, cysteine is in excess, a second equivalent of oxygen is given up by the complex acid in a slow reaction. The pH has a marked effect on the rate of the second reaction and the equilibrium point of the oxidation-reduction potential seems to shift with the pH. (S)

TRANSFORMATION OF HYDRATED CELLULOSE INTO NATIVE CELLULOSE. K. H. Meyer and N. P. Badenhuizen. *J. Nature*, 1937, V. 140, P. 281–2; abs. in *Paper Trade J.*, May 12, 1938, P. 48. (C)

TROPICAL CLOTHING: AIR CONDITIONS BETWEEN GARMENT AND SKIN. F. Marsh and P. A. Buxton. *J. Hygiene*, 1937, V. 37, P. 254–60 (through *Bull. Hygiene*, 1938, V. 13, P. 162–3); abs. in *J. T. I.*, May 1938, P. A302. (C)

THE VECTOR REPRESENTATIONS OF COLOR STIMULI. H. E. J. Neugebauer. *Z. wiss. Phot.*, 37, 32–5, No. 1/2, 1938; abs. in *Eastman Kodak Abs. Bull.*, July 1938.

Two vector representations of color stimuli are proposed as alternatives to the co-ordinate system, recommended by the International Commission on Illumination. The first uses complementary yellow and blue spectrum colors, and a green spectrum color to define the three basic vectors. The analogy between the color mixture curves and hypothetical sensitivity curves is completely abandoned in this discussion, and large negative values are encountered in the color specifications based on these spectrum primaries. A simple transformation of this system yields the so-called "Luther system" of color specification in which one parameter is brightness, and each of the other parameters is zero for all achromatic colors. (S)

VISCOSITY OF CELLULOSE SOLUTIONS. G. Saito. *J. Soc. Chem. Ind. (Japan)*, Feb. 1938, V. 41, P. 31B–33B; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

An important factor to be considered in discussions of viscosity of high molecular weight materials is the mean distance between neighboring particles in solution. By mathematical analysis it is shown that, for equal concentrations and equal numbers of dissolved particles, the average minimum distance between the particles is less for elongated than for roughly spherical particles. For the same concentration, the average value of the minimum distance passes through a maximum and then decreases with the length of the particle. A qualitative parallelism is noted between the length, the hydrodynamic reciprocal effect, and the viscosity of the solution. (S)

X-RAY ADVENTURES AMONG THE PROTEINS. W. T. Astbury. *Trans. Faraday Soc.*, 1938, V. 39, P. 378–88; abs. in *J. T. I.*, June 1938, P. A381.

According to X-ray analysis, the keratin molecule is a grid-like structure built up by means of a system of cross-linkages between the side-chains of neighboring main-chains. In equilibrium, the main-chains are folded or "buckled" out of the plane of the grid, but the latter is drawn out flat when it is pulled at the ends. The sub-microscopic crystallites of keratin appear to be simply piles of such grids. A description is given of the elastic mechanism of muscle fibre. The contracted states of the fibrous proteins are probably intermediate steps between the fully extended configuration and the multiple folds of the "globular" proteins. X-ray photographs and schemes are given for (*a*) β-type keratin; (*b*) normal collagen type (tendon); (*c*) α-type (unstretched keratin); (*d*) "supercontracted" collagen type (elastoidin contracted in hot water). Reference is made to the work of Bergmann and Niemann on the development of a stoichiometrical scheme for globular and fibrous proteins. (C)

XANTHOGENATION OF NATURAL CELLULOSE AND WATER-CELLULOSE: COMPARISON OF THE DEGREE OF. I. Sakurada and S. Okamura. *J. Soc. Chem. Ind. (Japan)*, March 1938, V. 41, P. 71B; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

Both water-cellulose and natural cellulose show the same degree of xanthogenation under similar conditions. The degree of xanthogenation is increased by acid treatment of the water-cellulose. (S)

X-RAY DIFFRACTION BEHAVIOR OF CELLULOSE DERIVATIVES. W. A. Sisson. *Ind. Eng. Chem.*, May 1938, V. 30, P. 530–37; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1938.

A review is given of the x-ray diffraction manifestations of cellulose derivatives with the customary methods of treatment. Complete references to the literature in the field are listed. (S)

Book Reviews

CHEMISTRY OF THE PROTEINS. Dorothy Jordan Lloyd and Agnes Shore, with an introduction by Sir F. G. Hopkins. 2nd Edition. J. & A. Churchill, Ltd., London, 1938. Pp. 532; price, cloth, 21s. Reviewed in *J. Soc. Dyers Col.*, Dec. 1938, P. 578.

Twelve years have elapsed since the first edition of this book was published, and in these years the published work in this field has been enormous. Thus, it is not surprising that the authors have found it necessary to double the original size of the book; it is a tribute to their skill that in these dimensions so much is included and balance maintained. (C)

INTRODUCTION TO CELLULOSE CHEMISTRY. J. T. Marsh and F. C. Wood, with a Foreword by Sir Kenneth Lee. Chapman & Hall, Ltd., London, 1938. Pp. 405; price, cloth, 21s. Reviewed in *J. Soc. Dyers Col.*, Dec. 1938, P. 577.

The publication of this book will be greatly appreciated by all chemists who are interested in cellulose and its derivatives. It is not a book for the amateur and, in spite of its title, it cannot strictly be termed an introduction to cellulose chemistry. Such a title gives the impression that it is a text-book for students, but as it consists mainly of the collected results of the work of cellulose chemists from about 1819, . . . it may be described best as a record of progress during the last 100 years. A welcome feature, however, is that the evidence advanced by many workers in support of, or against, various theories, is considered impartially and often summed up and discussed very skilfully. It is the most readable small book on cellulose that has appeared hitherto in English; its compilation could have been achieved efficiently only by chemists who, beside having had a wide experience of cellulose science and industry, have had ready access to a detailed and comprehensive reference system. (C)